oppositus by having the lateral-posterior margins of the thorax crenulated and by the prominent yellow band across the elytra. In general form it is nearest to *zonatus* Dall. but the latter has a much larger hind femora while the femora of phyllopus is only normally swollen. The scallops in the foliation of the hind tibiæ are rather shallow and much shorter than in *zonatus*. Specimens have been examined from Virginia south to Florida and Texas.

THE LIFE-HISTORY OF *MESOVELIA MULSANTI* WHITE.

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Among the most familiar inhabitants upon the surface of our ponds and quiet pools are the "skaters." These long-legged creatures that deport themselves with such ease and agility upon the surface of the waters have been noted by even the most casual observers. Their size and movements have forced at least a passing notice, but there are a number of small related species that escape all but those who look intently. Among these smaller forms is the little green *Mesovelia mulsanti*. It wears the brightest livery of them all, for the young and the apterous forms of the adults display varying degrees of green coloration, while the winged ones are even more conspicuous on the floating blankets of green algæ because of the silvery whiteness of their wings.

These insects measure only from four to five millimeters in length but are so distinct from other bugs in structure that they have been regarded as a distinct family.

At various times in the past they have been found in our collections associated with the *Hebridæ*, *Gerridæ*, *Hydrometridæ* and *Veliidæ* but at last have been segregated as the family *Mesoveliidæ*. The species here treated is the only one reported from the United States, but it is a widely distributed form.

It is at home in the haunts of the marsh-treader on the floating vegetation growing in the shallow waters of the pools, where the clumps of sedge spread their slender stems upon the water from the bordering bank, where young cat-tails spring up and green algæ carpet the surface of the waters.

Since they were first made known to science in 1852 by Mulsant and Rey, through the description of *Mesovelia furcata*, there has been added one other species, described by F. B. White (9)[1] from the Hemiptera collected in the Amazons by Prof. J. W. Trail and named *Mesovelia mulsanti*.

The information concerning the biology of these forms is meager and confined to a paper by Butler (2), 1893, on the "Habits of *Mesovelia furcata*," collecting notes on *M. furcata* by J. Scott (6) in England, and on *M. mulsanti* by Uhler (8) and by Bueno (1) in this country. It seems, therefore, worth while to present some notes concerning the biology of *Mesovelia mulsanti* whose habits and life-history are certainly among the most interesting of all the bugs that walk upon the surface of the inland waters.

They may be separated from the other bugs of the surface film by the following synoptic table prepared by Mr. H. M. Parshley:

A. Head as long as entire thorax; body and appendages extremely slender ..... *Hydrometridæ*

AA. Head shorter than thorax; form stout or moderately elongate.

B. Claws inserted at apex of last tarsal segment.

C. Antennæ 5-segmented (except in *Merragata*); clavus membranous; membrane without veins ..... *Hebridæ*

CC. Antennæ 4-segmented.

D. Membrane without veins; hind coxæ rotatory; color greenish; wingless form common ..... *Mesoveliidæ*

DD. Membrane with distinct veins forming elongate cells; hind coxæ hinged; color not greenish; wings more or less developed ..... *Saldidæ*

BB. Claws inserted before apex of last tarsal segment.

C. Hind femora not extending much beyond apex of abdomen; middle pair of legs about equidistant from front and hind pairs (except in *Rhagovelia*) size usually minute ..... *Veliidæ*

CC. Hind femora extending much beyond apex of abdomen; middle and hind pairs of legs approximated, very distant from front pair; size moderate, rarely minute ..... *Gerridæ*

[1] See Bibliography.

Habitat and Food Habits.

It has been indicated above that these little bugs live upon the floating vegetation of ponds. Butler (2) found them on Potamogeton and Bueno (1) on duck weed, matted Hydrodictyon or other algæ. The writer has found them about old logs projecting from the water—clumps of smartweed at the water's edge as well as on rafts of filamentous algæ and leaves and stems of plants procumbent upon the surface.

They were noted by Butler to be carnivorous in tastes. He fed them a variety of small insects and saw them feeding upon a springtail, (Smynthurus), a Crambus, a Chalcid and a Hydrometra and supposed the usual food to be small Diptera and Hymenoptera. As to whether they caught their prey alive or availed themselves of the drowned and disabled specimens he was unable to say. That *M. mulsanti* can live upon such fare is certain for the writer has reared them on flies and plant lice cast upon the water.

They are cautious creatures but do on occasion fall upon fairly lively prey, as evidenced by the following instance: A fly thrown into the aquarium was seen to crawl up the side of the jar bearing an adult female *Mesovelia* with its beak attached near the caudal end of the fly which when disturbed flew to a nearby support bearing the tenacious little bug.

However, the writer has come to believe that, with Hydrometra, Microvelia and Rheumatobates, they are not dependent upon the chance and uncertain fare of terrestial insects caught upon the surface film but find another, and indeed a more constant source in the organisms that dwell below but come up to the surface film. Among these, Ostracods and like forms are available as more or less staple food and Mesovelia have been observed exploring the sides of floating Typha and the tangled mats of algæ for such Crustacea which they spear from the surface of the water.

The tiny nymphs feed upon more gentle organisms in the water, as there are few upon the surface that they are able to overcome. When offered springtails as suggested by Butler, disaster often followed and the writer lost many good rearings before he learned the inadvisability of offering such food. The hungry little creatures would attack them only to be turned topsy-turvy upon the water even by comparatively small springtails. Plant lice afforded

less risk of this kind and gave better results. They were used as the food supply in the isolation rearings where a study of molts was made. But in an aquarium twelve inches in diameter, the water of which contained algæ and floating sedge stems amongst which dwelt an abundant population of entomostracans, the little bugs were reared through their complete cycle without other resource than that afforded by the waters and the weaker of their own kind.

Life-History.

Technique in Rearing.

Butler states that "pairing took place several times and the bodies of the females became, by the end of three weeks, greatly distended." The specimens died, however, without ovipositing and his conclusion in regard to the matter, in the light of our present knowledge, seems amusing. It is only fair, however, to state that the writer had the same experience until he discovered that the female possesses an ovipositor for inserting her eggs into the tissues of plants. The newly hatched young were isolated in small stender dishes upon a very shallow film of water with a small bit of sedge stem for a support. The water was kept fresh and clean for the health of the bug and to facilitate finding the molt skins.

Oviposition.

Since Mesovelia hides and protects its eggs by burying them in the tissues of certain plants that are associated with shores and shallow waters the female possesses an ovipositor adapted to this purpose. If the female be examined in lateral view the abdomen is seen to be laterally compressed at its caudal end in such a manner as to provide a sheath or groove for the ovipositor (Pl. I, Fig. 13). A dissecting needle inserted near the distal and caudal end of this fissure can be used to pry out and bring to view a shiny brown chitinized organ which may be turned down into a position approximately at right angles to the body, for its attachment is at the basal end of the sheath. In this position it is seen to be curved so that the tip is directed slightly forward. The general shape, viewed from the front, is roughly spear shaped and the parts

arranged in such a way that the front surface is concave forming a wide groove, reminding one, when in action, of the tip of an apple corer. Upon dissection it is seen to be made up of three parts, two lateral shafts that are strongly chitinized and toothed or serrated along the lower portion of their lateral margins and a broader central plate (see Pl. I, Figs. 14 and 15). The lateral shafts are attached to the flat plates of the abdominal wall. The central portion is in reality made up of paired parts attached to the median pair of selerites that serve as the valves or shields for the ovipositor.

The manipulation of this instrument during oviposition may be observed any time during the spring, summer or autumn by confining a number of mating insects in a petrie dish containing only clear water and some food. After being thus deprived for a couple of days of materials in which to place their eggs they will gather about a small bit of sedge stem or cat tail leaf supplied them, and most eagerly set about the business of laying eggs. The writer has seen as many as eight thus employed about a portion of sedge stem one and one-half inches long and has had ample opportunity to watch the process under the binocular.

The female frequently explores the stem with the tips of her beak and antennæ if indifferent in the matter, but if eager to oviposit, she mounts the stem without delay, raises the abdomen slightly, unsheaths the ovipositor and turns its tip down to the surface of the stem. At times the surface is tested out at several points—again if the first point of contact is favorable, the tip is caused to quiver back and forth till it gains a footing, and then rocking the body slightly from side to side the entire drill is caused to rotate or twist back and forth on its axis—rapidly at times, or again more slowly as may suit the necessity of the work, until a hole is effected and the ovipositor is buried to its base. During the deeper drillings the longitudinal alternate thrusts of the drill parts are apparent. The first part of the operation at least involves much the same sort of a motion as one employs in making a hole with a gimlet or awl.[1]

[1] In addition to the twisting motion and the alternate thrusts of the stylets there is yet another. It is the expanding or spreading of the drill parts during the enlarging or reaming out of the hole.

It takes but a moment in the spongy water-soaked stem of a sedge to drive the instrument up to its base. Then, after a moment of apparent quiet, the ovipositor is lifted slightly and the egg is forced by a series of abdominal contractions down the ovipositor and into the cavity reamed out to receive it.

The egg when forced into the ovipositor distends it considerably as it passes through its channel and thus can be seen to slip down into position with its distal end directed forward beneath the insect. The ovipositor being at last withdrawn from beneath, the egg slips out from behind the exposed circular end of it.

A number of eggs may be imbedded thus, in the stem before the ovipositor is sheathed—each one requiring a separate puncture. In the cylindrical stems of plants procumbent upon the water the eggs are likely to be inserted on the sides as they come in contact with the surface film, but this is by no means necessarily the case.

As frequently as not the male accompanies the female during the process. Having mounted her in mating he merely moves forward and remains perched upon her back as she busies herself with egg laying, mating being attempted and often consummated between her labors. [1]

In starting the drill in a particularly stubborn or inconvenient place the female not infrequently uses one of her hind legs to steady and stiffen or support the drill. One female after making several attempts employed her right hind leg in such a manner that the tarsus was turned at an angle with the tibia and the angle thus formed used to direct and aid the ovipositor.

During the process of oviposition the female often defends herself from molestation by kicking vigorously with the hind legs when disturbed.

Description of Egg.

Size: Length .875 mm.; greatest diameter .187 mm. to .250 mm.; diameter of exposed circle .15 mm.

Shape: This shape is best shown in the drawing. The egg is elongate oval with a curved neck terminating in a flat surface which

[1] In mating the male mounts the female—clasps his fore legs around her mesothorax in front of her middle legs—rests his middle legs upon the water film or other supporting surface and holds the hind legs poised in the air. The copulatory organ of the male is long and curves around the side of the tip of the female's body to come into contact with the genital opening. Contact lasts from a few seconds to one minute or longer. Upon withdrawal the copulatory organ is seen to be a slender white tube of astonishing length.

marks the exposed end of the egg as it lies *in situ* in the stem of some plant.

Color: When first laid, white; in the course of two or three days it has become watery transparent with portions of the embryo beginning to take form. These eggs buried singly as indicated above are shown in the drawings (Pl. I, Figs. 5 and 7). The exposed end of the egg shows up as a shiny membranous circular spot on the surface of the plant which bears it and is visible to the naked eye. This spot, though clear white when first laid presents at about the second day a very faint ring of pink which darkens to a deep pink after twenty-four hours. In the course of another day or two this gradually fades and two days before hatching the deep red eye spots may be seen through clear stems in the position shown in Fig. 7

The egg stage lasts seven to nine days. At hatching the young nymphs, still enclosed in their embryonic membrane, work their way up through the little circular openings of the stem. This is a remarkable feat considering the size of the nymph and the size of the hole but is aided materially by the peculiar backward pointed pegs on the thin embryonic membrane. When well out of the stem this membrane is cast and the nymph takes its place upon the water.

First Instar.

Size: See the table presented below.

Color: When first hatched it is white with red eyes darkening to amber and green as it ages. To the unaided eye it is greenish brown. Thus it is much darker than the older nymphs, quite distinct in coloring. The tips of the appendages are dark while the limbs themselves are pale.

Structural Peculiarities.—The general form is stouter and more robust than that of the later stages. The body and limbs are clothed with hairs and bristles as shown in the Fig. 4. The head and thorax bear a few stout bristles and the antennæ bear on the first segment several (usually 3 or 4) stout bristles directed mesally and the terminal segment is thickly covered with fine hairs. The limbs, besides bearing many hairs possess a number of black bristles arranged as follows: One stout bristle is prominent near the distal end on the anterior margin of the meso- and meta-thoracic

femura. The metathoracic tibia are beset with numerous irregularity arranged bristles. Terminating with one larger than the others.

The antennæ are stout and as long as the body, four segmented, the terminal segment is somewhat broadened and as long as the other three. The head bears no indication of ocelli but does possess the black bristles indicated in the later instars.

The limbs are stout, the tarsi one-segmented and ending in two claws.

The abdomen bears a dorsal pore on the median line of the dorsum of the fourth abdominal segment.

Later Instars.

The second and later instars are bright green in color and more slender in form. They possess relatively fewer hairs on the body—but retain the black bristles in the positions indicated in the first instar. There appear in these later instars one black bristle on anterior margin of fore femur and two on the other femora. The structural characters remain constant until the adult stage is reached when the following changes become apparent.

The first antennal segment possesses but one black bristle instead of a number of them (usually).

The limbs are more slender and tarsi 3-segmented.

The connexivium is broad and the sexual characteristics appear.

In the winged female there appear two dark ocelli-like spots on the vertex.

The winged forms are often found with membrane missing. They have been observed to break away this portion of the wing with the hind tibia, exposing the tip of the abdomen as shown in Fig. 1.[1]

Following is given a table of measurements of the various instars and of the adults:

[1] Mr. J. R. de la Torre Bueno describes this habit in Halobatinæ. Canadian Ent., Vol. IX, No. 1, p. 389 (1908)

TABLE OF MEASUREMENTS IN MILLIMETERS OF INSTARS OF MESOVELIA MULSANTI.

Stage.	Measurement from tip of femur to tip of femur.	Antennæ.				Hind leg.			Middle leg.			Fore leg.		
		1st seg.	2d seg.	3d seg.	4th seg.	Femur.	Tibia.	Tarsi.	Femur.	Tibia.	Tarsi.	Femur.	Tibia.	Tarsi.
1st instar....	1.	.149	.099	.11	.416	.416	.573	.211	.336	.306	.166	.25	.213	.129
2d "	1.25	.20	.125	.20	.5	.54	.625	.225	.35	.343	.188	.312	.26	.135
3d "	1.5	.25	.166	.207	.54	.625	.85	.275	.437	.44	.225	.375	.33	.167
4th "	2.125	.29	.21	.32	.75	.81	1.	.375	.625	.625	.29	.5	.38	.25
5th "	2.5	.375	.29	.375	.81	1.03	1.37	.437	.75	.75	.375	.625	.50	.26
6th ♂.....	.....	.65	.416	.716	.96	1.35	1.56	.5	1.09	1.09	.416	.858	.75	.26
6th ♀.....	.....	.59	.39	.65	.79	1.56	1.95	.65	1.17	1.17	.52	.91	.78	.312

Before attaining the adult stage, the nymph passes through five nymphal instars spending from two to three days in each stage. Mating occurs and oviposition begins about the third day. One female emerged August 1, began to lay August 3 and died August 12, having laid 44 eggs an average of nearly 5 eggs per day. Some of the females in isolation laid an average of less than this, while one female under observation laid 18 eggs in 24 hours, a surprisingly large number, when we consider the size of egg and adult. The table presented on p. 82 is the history of one of a number of series, of isolation rearings, and indicates the variations in the duration of the different stages. The record of the many that died after isolation is omitted. It represents at least 90 per cent. of the total for mortality is very heavy under laboratory conditions. However, rearing in isolation and in close confinement is the only way to arrive at the number of molts and duration of instars. When a number are reared together the close resemblance of the instars and the variation in size within a given instar makes precise observation impossible. The writer has endeavored to determine diagnostic characters for the various instars. In the apterous forms he has found the spread from tip of femur to tip of femur the only fairly satisfactory determination (see table above). The developing winged forms beginning with the third instar are readily placed. (See Fig. 3 for the size of the wing pads in the 5th instar.)

MESOVELIA MULSANTI—A HISTORY OF A FEW ISOLATED REARINGS.

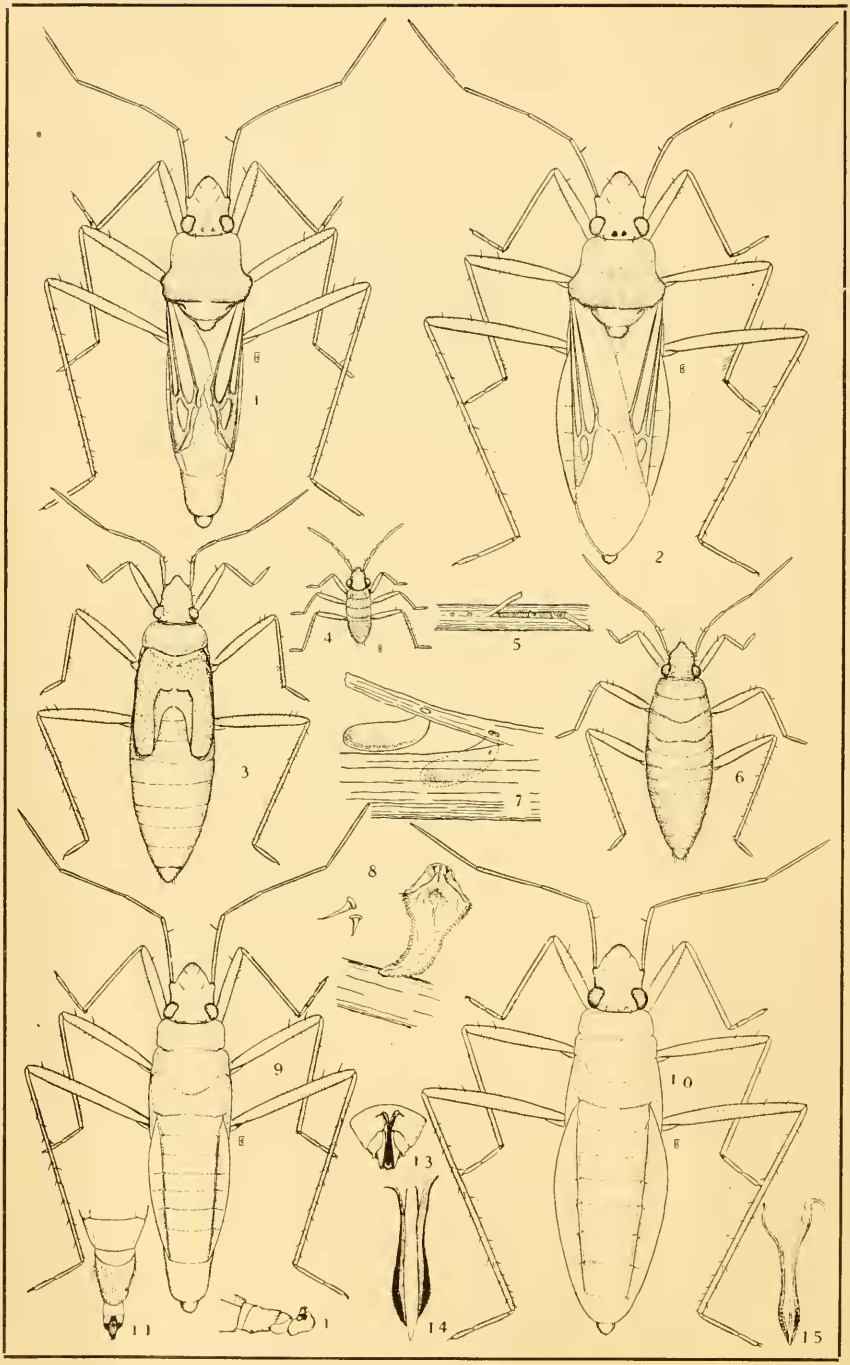
Exp. No.	Lot. No.	Egg laid.	Egg hatched.	1st molt.	2d molt.	3d molt.	4th molt.	5th molt.	Mated.	Eggs laid.	No. of eggs.	Died.
1685.....	1643	7/ 5/16	7/13/16	7/18/16	7/19/16	7/22/16	7/24/16	7/27/16	7/29/16	7/30/16	26	8/ 5/16
1643	1643	7/ 5/16	7/13/16	7/16/16	7/19/16	7/22/16	7/24/16	7/26/16	♂	.....	....	7/30/16
1688.....	1643	7/ 5/16	7/13/16	7/15/16	7/16/16	7/19/16	7/22/16	7/25/16	♀	7/28/16	15	8/ 2/16
16142.....	1657	7/13/16	7/21/16	7/23/16	7/25/16	7/27/16	7/29/16	8/ 1/16	♀	8/ 4/16	21	8/ 9/16
16x.....	....	7/24/16	8/–1/16	8/ 3/16	8/ 6/16	8/ 8/16	8/11/16	8/14/16	♂	.....	....	8/22/16
16y.....	....	7/13/16	7/21/16	7/23/16	7/25/16	7/27/16	7/29/16	8/ 1/16	♂	.....	....	8/ 7/16
1657.....	1657	7/13/16	7/19/16	7/21/16	7/23/16	7/26/16	7/29/16	7/31/16	♀	.....	....	7/31/16
16571.....	1657	7/13/16	7/20/16	7/22/16	7/24/16	7/26/16	7/29/16	8/ 1/16	8/ 4/16	8/ 9/16	10	8/ 6/16
16197.....	....	7/13/16	7/20/16	7/22/16	7/25/16	7/27/16	7/29/16	8/ 1/16	8/ 3/16	8/ 4/16	44	8/12/16

Summary.

Mesovelia mulsanti is found about the margins of ponds and pools upon floating vegetation where it feeds upon small organisms coming to the surface film from below or that fall upon it. The species probably passes the winter as adults that begin ovipositing in the spring. They place their eggs in the stems of plants and even in the spongy wood of floating logs.[1] There is a succession of generations throughout the season, each cycle requiring about twenty-four days. Winged and wingless forms occur together. Besides flying from pool to pool, they may be transferred in the egg stage. Mr. Beamer sent them from the southern part of the state to the writer at Lawrence, Kans., in the stems of sedge used as packing for some Naucorids.

The general distribution of this species, and the ease with which it may be controlled and observed both as to oviposition and to hatching, make it a valuable object for studies on these phases of animal behavior.

[1] Since this paper was submitted for publication the writer has learned from Mr. J. R. de la Torre Bueno that he found the eggs of these bugs in plants some years ago. This gives him priority of observation on this point.



HUNGERFORD—Life-History of *Mesovelia mulsanti*.